**[Evolution: The Curious Case of Dogs |](http://blogs.scientificamerican.com/science-sushi/2011/11/13/observations-evolution-the-curious-case-of-dogs/" \o "Permanent Link to Evolution: The Curious Case of Dogs | Observations) *[Observations](http://blogs.scientificamerican.com/science-sushi/2011/11/13/observations-evolution-the-curious-case-of-dogs/" \o "Permanent Link to Evolution: The Curious Case of Dogs | Observations)***

By [Christie Wilcox](javaScript:void(0)) | November 13, 2011|

*This is the first in a series of post of mine about Evolution that I started posting in January of 2010. I’ll be reposting the series over the next two months, culminating in a brand new post for the set in Jan 2012! I’m excited. You know you’re excited. Enjoy!*

Man’s best friend is much more than a household companion – for centuries, artificial selection in dogs has made them prime examples of the possibilities of evolution. A century and a half ago, Charles Darwin recognized how the incredibly diverse dogs supported his revolutionary theory in his famous book *On The Origin Of Species*. At the time, he believed that dogs varied so much that they must have been domesticated from multiple canine species. Even still, he speculated that:

*if… it could be shown that the greyhound, bloodhound, terrier, spaniel and bull-dog, which we all know propagate their kind truly, were the offspring of any single species, then such facts would have great weight in making us doubt about the immutability of the many closely allied natural species*

If only Darwin knew what we know now, that indeed, all dogs did descend from one species!

While humans have been breeding dogs for over ten thousand years, it was until recently that strict standards and the emphasis on “purebreds” has led to over 400 different breeds that are some of the best examples of the power of selection. Those that doubt whether small variations in traits can lead to large levels of diversity clearly haven’t compared a Pug to a Great Dane – I mean, just *look* at them compared to their ancestor:





We’ve turned a fine-tuned hunting animal, the wolf, into a wide variety of creatures, from the wolf-looking shepherds to the bizarre toy breeds. Before domestication, dog’s life was tough. But when people pulled specific wolves out of their packs and began breeding them, we changed *everything*. There were some traits that made this easy – the social structure of wolves, for example, made them predisposed to belonging to a community. Still, we opened up a number of genetic traits and allowed them to express variety that would have been fatal in the wild. We not only allowed these traits to persist, we *encouraged* them. We picked dogs that were less aggressive or looked unique. And in doing so, we spurred on rapid diversification and evolution in an unbelievable way.

Take their skulls, for example. Like other members of the order Carnivora, dog’s skulls have a few distinctive characteristics: relatively large brains and a larger-than-normal structure called a zygomatic arch which allows for bite power and chewing. But years of hand-picked puppies has led to an amazing amount of skull diversity in dogs. A study recently compared the positions of 50 recognizable points on the skulls of dogs and compared them to each other and other members of the order Carnivora. They found that there was as much variety in the shape of the skulls of dogs as in the entire rest of the order, and the extremes were further apart. [](http://nerdychristie.files.wordpress.com/2010/01/pug_skull_v_great_dane_skull.png)What does that mean, exactly? It means that the differences between the skulls of that Pug and Great Dane I mentioned before (on R) are greater than the differences between the skulls of a weasel and a walrus. Much of this variation is outside the range of the rest of the order, meaning dogs’ skull shapes are entirely unique. In just a few centuries, our choices have created unbelievable variety in the heads of dogs – more than 60 million years has created in the rest of the carnivores.

The amazing diversity of dogs is a testimonial to the possibilities of selection. And it’s not just their skulls that vary. A joint venture between the University of Washington and the Veterinary School at UC Davis mapped the variation in the genomes of a mere 10 different breeds of dogs. They found that at least **155** different regions of the dog’s genome show evidence of strong artificial selection. [](http://nerdychristie.files.wordpress.com/2010/01/shar_pei.png)Each region contained, on average, 11 genes, so it’s harder to identify exactly what about each area was under the most selection, though there were clues. About 2/3 of these areas contain genes that were uniquely modified in only one or two breeds, suggesting they contain genes that are highly breed-restricted like the skin wrinkling in the Shar-Pei. Another 16 had variations in 5 or more breeds, suggesting they encode for traits that are altered in every breed, like coat and size.

While we usually think of evolution as a slow and gradual process, dogs reveal that incredible amounts of diversity can arise very quickly, especially when selective pressures are very, very strong. It’s not hard to see how selection could lead to the differentiation of species – just look at the breeds of dogs that exist today. There’s a reason that you don’t see many Chihuahua/Saint Bernard mixes: while it’s entirely *possible* for their genetics to mix, it’s just *physically difficult* for these two breeds to actually do it. Just imagine what a poor Chihuahua female would have to endure to give birth to such a mix, or how hard it would be for male Chihuahua to mount a female Saint Bernard. Indeed, dogs are well on their way to speciation.

Of course, it’s at this point that I have to mention that while I have talked about “dogs” this entire time, they’re not actually a different species. Wolves are *Canis lupus*, while dogs are merely a subspecies of wolves, *Canis lupus familiaris*. Despite centuries of selective breeding and the vast array of physical differences, dogs are still able to breed with their ancestors.

When you take away the selective breeding done by humans, a number of these unique traits disappear. But feral dogs don’t just become wolves again – their behaviors and even looks depend greatly on the ecological pressures that surround them. Our centuries of selective breeding have opened a wide variety of traits, both physical and behavioral, that may help a stray dog survive and breed.

A good example of what happens to dogs when people are taken out of the picture can be found in Russia’s capital city. Feral dogs have been running around Moscow for at least 150 years. These aren’t just lost pets that band together – these dogs been on their own for awhile, and indeed, any poor, abandoned domesticated canine will meet an unfortunate fate at the hands of these territorial streetwalkers. Moscow’s dogs have lost traits like spotted coloration, wagging tails and friendliness that distinguish domesticated dogs from wolves – but they haven’t become them. The struggle to survive is tough for a stray, and only an estimated 3% ever breed. This strong selective pressure has led them to evolve into four distinct behavioral types, according to biologist Andrei Poyarkov who has studied the dogs for the past 30 years. There are guard dogs, who follow around security personnel, treating them as the alpha leaders of their packs. Others, called scavengers, have evolved completely different behaviors, preferring to roam the city for garbage instead of interacting with people. The most wolf-like dogs are referred to as wild dogs, and they hunt whatever they can find including cats and mice.

[](http://nerdychristie.files.wordpress.com/2010/01/moscow_subway_dog.jpg)But the last group of Moscow’s dogs is by far the most amazing. They are the beggars, for obvious reasons. In these packs, the alpha isn’t the best hunter or strongest, it’s the *smartest*. The most impressive beggars, however, get their own title: ‘metro dogs’. They rely on scraps of food from the daily commuters who travel the public transportation system. To do so, the dogs have learned to navigate the subway. They know stops by name, and integrate a number of specific stations into their territories.

This dramatic shift from the survival of the fittest to the survival of the smartest has changed how Moscow’s dogs interact with humans and with each other. Beggars are rarely hit by cars, as they have learned to cross the streets when people do. They’ve even been seen waiting for a green light when no pedestrians are crossing, suggesting that they have actually learned to recognize the green walking man image of the crosswalk signal. Also, there are fewer “pack wars” that once were commonplace between Moscow’s stray canines, some of which used to last for months. However, they remain vigilant against the wild dogs and wolves that live on the outskirts of the city – rarely, if ever, are they permitted into Moscow. When politicians thought to remove the dogs, their use as a buffer against these animals was cited as a strong reason not to disturb them.

Moscow’s exemplary dogs show how different traits help dogs adapt to different ecological niches – whether it be brute strength for hunting in the truly feral wild dogs or intelligence in the almost-domesticated beggars. Some wonder if the strong selection for intellect will make Moscow’s metro dogs into another species all together, if left to their own devices.

Dogs make it easy to understand and demonstrate the core principles of evolution – variation and selection – and how they can make such a dramatic impact on an animal. It’s no wonder that Darwin took cues from domesticated animals when formulating his theory of evolution. However, there’s still a lot to learn about the processes that have shaped our best friends, and what future lies for them. How much time will it take to completely separate dogs from wolves, into their own species? What areas of the genome are key to doing so? In studying dogs and wolves, we may gain insight into how speciation occurs and when a threshold of change is met for it to do so. Seeing how much change has occurred already makes you wonder what surprises our canine companions still have in store for us as they, and we, continue to evolve together over the next ten thousand years.

Citations:  
Drake, A., & Klingenberg, C. (2010). Large Scale Diversification of Skull Shape in Domestic Dogs: Disparity and Modularity *The American Naturalist* DOI: [10.1086/650372](http://dx.doi.org/10.1086/650372)

Akey, J., Ruhe, A., Akey, D., Wong, A., Connelly, C., Madeoy, J., Nicholas, T., & Neff, M. (2010). Tracking footprints of artificial selection in the dog genome *Proceedings of the National Academy of Sciences, 107* (3), 1160-1165 DOI: [10.1073/pnas.0909918107](http://dx.doi.org/10.1073/pnas.0909918107)

Poyarkov, A.D., Vereshchagin, A.O., Goryachev, G.S., et al., Census and Population Parameters of Stray Dogs in Moscow, Zhivotnye v gorode: Mat-ly nauchno-prakt. konf. (Proc. Scientific and Practical Conf. Animals in the City ), Moscow, 2000, pp. 84 87.

Vereshchagin, A.O., Poyarkov, A.D., Rusov, P.V., et al., Census of Free-Ranging and Stray Animals (Dogs) in the Coty of Moscow in 2006, Problemy issledovanii domashnei sobaki: Mat-ly soveshch (Proc. Conf. on Problems in Studies on the Domestic Dog), Moscow, 2006, pp. 95 114.

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